Software Overview and Common Projects

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DOE/NSF LHC Computing Review
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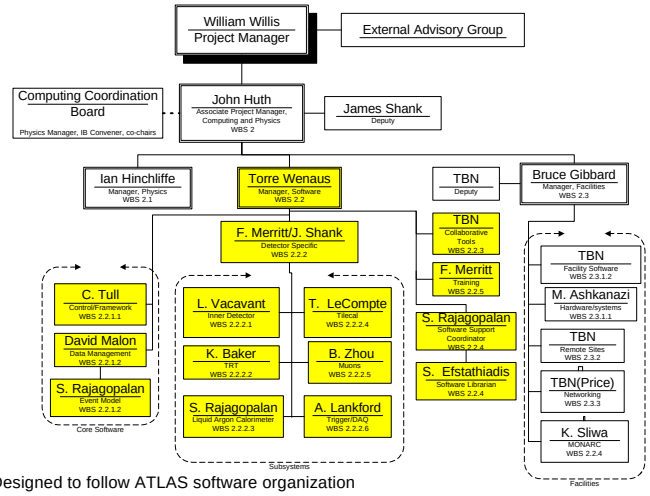
Outline

- U.S. ATLAS Software Organization and ATLAS roles
- Strategy and Scope
- Personnel Support Requests
- Software development efforts
  - Control/Framework
  - Data Management
  - Subdetector Software
  - Program linkages
  - Collaborative Tools
- Software Support
- Software Training
- Common Projects
- Conclusions

Software Subproject Responsibilities

- **Software Subproject - WBS 2.2:** Software projects that are part of the overall ATLAS (also LHC) software effort. Includes contributions assumed by U.S. as part of an overall MOU (in development) with ATLAS for software deliverables
- **Core Software - WBS 2.2.1**
  - **Control/Framework (C. Tull) - WBS 2.2.1.1**
  - **Data Management (D. Malon) - WBS 2.2.1.2**
    - **Event model (S. Rajagopalan)**
  - **Analysis Tools - WBS 2.2.1.3**
  - **General simulation and reconstruction software - WBS 2.2.1.4**
- **Subsystem software (F. Merritt/J. Shank) - WBS 2.2.2**
  - **Simulation, reconstruction, subsystem-specific database**
  - **Silicon, Transition Radiation Tracker, Liquid Argon, Tile Calorimeter, Muon, Trigger/DAQ, Background Studies**
- **Collaborative tools - WBS 2.2.3**
- **Software Support (S. Rajagopalan) - WBS 2.2.4**
- **Training (F. Merritt) - WBS 2.2.5**

U.S. ATLAS Software Organization



Designed to follow ATLAS software organization

Major U.S. Software Positions in ATLAS

Scope of U.S. ATLAS software program follows the domains in which U.S. has important capabilities and responsibilities, reflected in ATLAS roles...

- **Core Software**
  - **Control/Framework**
    - **Craig Tull - Architecture Team**
    - **David Quarrie – Architecture Team, Task Force**
    - **Paolo Calafiura – Architecture Team**
  - **Data management**
    - **David Malon - Co-leader of database group**
- **Subdetector Software**
  - **Misha Leltchouk - LAr simulation Coordinator**
  - **Michael Shupe - Convenor of Background working group**
  - **Fred Luehring - TRT software Coordinator**
  - **Steve Goldfarb - Muon Database Coordinator**
  - **Tom LeCompte - Tilecal Database Coordinator**
  - **Frank Merritt - Training contact, Tilecal Reconstruction Coordinator**

Communication

- **Weekly technical control/framework meeting with data management participation**
- **Will be supplemented (after Review Season) by a regular technical software meeting for U.S. ATLAS complementing the existing bi-weekly U.S. ATLAS computing meeting**
- **Physically together at ATLAS computing weeks; (very) occasional U.S. ATLAS computing meetings (last Aug)**
  - **must be efficient with travel $!**
- **Web site, of course**
  - **Adding web-based discussions (HyperNews)**

Strategy and Scope

- The Subproject program reflects those ATLAS software activities in which the U.S. can bring unique capabilities to bear on key domains in which our involvement will strengthen both ATLAS and the participation of the U.S. in the ATLAS physics program
  - Core software domains central to offline data processing, physics analysis, data management, and the distributed data management and analysis capability essential to the U.S.
  - Subsystem software domains building on the detector hardware responsibilities of U.S. institutes
- Level of participation scoped at ~20% of the total effort
  - Commensurate with overall U.S. ATLAS scope
- Our focus on limited, coupled software domains will permit strong ATLAS roles in these areas and a coherent program
- The U.S. seeks and is successfully accruing leadership roles in our focus domains

Strategy and Scope (2)

- FY00 requests are tightly focused on the tasks in which an early ramp is essential to ATLAS and important to secure targeted U.S. responsibilities
- The core software support profile to '06 is based on continued focus on the selected areas with a software professional corps scaled to the leading U.S. role we foresee in these areas and estimated from existing experiments
- The subdetector software support profile is based on a professional complement of 2 per subsystem supporting a large number of base program physicists in subsystem specific implementations and interfaces to core components, software development and maintenance support

FY00 Core Software Personnel

FY00 Physicists and Professionals in planned core software program

	ANL	LBNL	BNL	U of Michigan
Control/Framework SW Professionals		C. Tull 1.0 D. Quarrie 0.5 (0.8) C. Day 0.67 (1.0) New Hire 0.67 (1.0) J. Milford 0.25 (0.5)		
Control/Framework Physicists		I. Hinchliffe 0.5 M. Shapiro 0.2 P. Calafiura 0.6 C. Leggett 0.6	T. Wenaus 0.2	
Data Management SW Professionals	D. Malon 1.0 G. Pandola 0.25 (0.5) J. Christiansen .25 (.5) New Hire 0.5 (1.0)		New Hire 0.5	New Hire 0.5
Data Management Physicists	T. LeCompte 0.5 E. May 0.6 R. Wagner 0.5 R. Blair, L. Price, and others 0.4		S. Rajagopalan 0.5 S. Protopopescu 0.1 S. Snyder 0.1	S. Goldfarb 1.0 (muon subsystem)

FY00 Other Professional Support

- **Subsystem software development**
  - **WBS 2.2.2.3 - LAr simulation and reconstruction**
    - **W. Seligman, 1 FTE, Nevis Lab**
  - **WBS 2.2.2.4 - Tilecal simulation and reconstruction**
    - **TBN, 1 FTE, U. of Chicago**
  - **NB. Total current U.S. ATLAS software participants, most involved in subsystem software: ~50**
- **U.S. ATLAS software support**
  - **WBS 2.2.4 – Software Librarian**
    - **S. Efstathiades, 1 FTE, BNL**

Control/Framework Software - WBS 2.2.1.1

- Operating environment for software modules written by physicists
- Strong experience base in U.S. groups (LBNL, BNL)
- Urgent focus of recent ATLAS planning and activity
- Architecture Task Force (ATF) recently concluded
  - To specify a global ATLAS computing architecture for unified execution framework
  - US participation: D. Quarrie, M. Shapiro of LBNL
  - Component architecture outlined; strategic architectural decisions

Control/Framework (2)

- Post-ATF: Architecture Team being formed for design/implementation
  - Work of LBNL group instrumental in establishing U.S. role
    - Experience in many frameworks, eg. BaBar, CDF, RHIC
    - Surveyed existing frameworks
  - U.S. (LBNL) members appointed: Quarrie, Tull, Calafiura (of ~6)
  - Aggressive initial milestone: functional framework for May 2000
    - GAUDI framework (LHCb) to be used as basis
  - Plans elsewhere in U.S. to contribute in testbed prototyping and related development, e.g.
    - Database effort, event model, subsystems

Data Management Software - WBS 2.2.1.2

- Event store, databases, distributed data, …
  - Joint responsibility for event model, detector description...
- Faces much of the scale and complexity impact of ATLAS: managing Petabyte data stores
- Strong U.S. experience base at ANL, LBNL, BNL
  - HENP Grand Challenge, BaBar, RHIC
- U.S. well integrated into ongoing ATLAS effort, with major roles
  - David Malon (ANL) Co-Leader of ATLAS database domain
    - Database expert; RD45, HENP Grand Challenge
  - U.S. also represented in subsystem database leaders
    - Muon (Steven Goldfarb, U Michigan)
    - Tilecal (Tom LeCompte, ANL)

Data Management Software (2)

- U.S. program exploits close couplings of this domain to other U.S. efforts
  - Control framework interface
  - Detector description and geometry data management
  - Database support for Geant4 based simulation
  - Event model and control framework prototyping in reconstruction
  - Continued use of tile test beam as testbed for core development and production use of Objectivity

Subsystem Software - WBS 2.2.2

- Wide range of activities in universities and labs
- The Software Project will
  - Manage Project resource requests and allocations among activities
  - Seek to strengthen contributions to ATLAS and U.S. ATLAS through couplings and commonality between subsystem programs and with U.S. core activities for coherent U.S. program (e.g. next slide)
  - Not supplant ATLAS computing coordination; U.S. activities take place in the context of and under the management of ATLAS computing (ditto for core activities)

Linking Core and Subsystem Programs

- Goal in U.S. program: Combining strong core and subsystem software roles to closely couple core development to real-world testbeds and applications
  - Recognized in ATLAS as very important
- Examples (lead institution is indicated):
  - Tilecal test beam pilot project (ANL) with first production application of Objectivity in ATLAS
  - Muon database effort (U Mich) as framework for development and testing of XML detector descriptions and database
  - LAr OO reconstruction (BNL) as testbed for control framework and prototype for event model development
  - Si pixel test beam simulation (LBNL) to be integrated into control framework as application testbed

Collaborative Tools - WBS 2.2.3

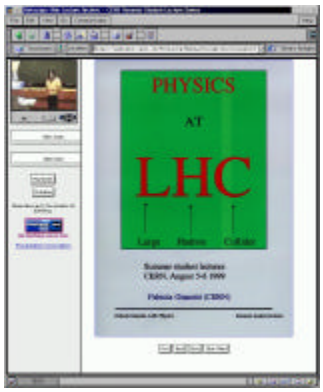
- **Tools allowing collaboration among distributed sites**
  - **Video and web based conferencing, whiteboard tools, electronic notebooks, collaborative software development and physics analysis**

Collaborative Tools: Syncomat

The University of Michigan Web-Based Activity Capture Application: Syncomat

A system for the high quality archiving and replay of captured audio and video in synchronization with slides

- **Developed by Charles Severance of the University of Michigan**
- **Operates on any platform and is of no cost to the client user**
- **Tested by the University of Michigan ATLAS Collaboratory Project during Summer 1999 by recording many of the CERN Summer Student lectures and several software training presentations (covering LHC++, database technology and software engineering)**



H. Neal; Jan. 7, 2000

Syncomat - Plans

- Pilot project for lectures and tutorials (Andrea Del'Acqua) relevant to (U.S.) ATLAS
  - $25k proposal for student support
- U of Michigan plans R&D utilizing QoS protocol
- NSF ITR pre-proposal submitted involving Michigan, Internet2, MERIT and CERN
- Anticipate strong collaboration with CMS, ATLAS and the CalTech VRVS Group
- Advances will be immediately fed back to ongoing LHC software training activities

H. Neal; Jan. 7, 2000

DOE 2000 Collaboratory Tools

- Tools and technologies supporting network based collaboration
- Now available for use in LHC program:
  - Video conferencing tools (eg. Mbone)
  - Electronic notebooks
    - Web browser based text, video, images, other media
- Security and Quality Of Service mechanisms to enhance control and performance of collaborative applications.
- U.S. ATLAS will incorporate tools into ATLAS
  - Stu Loken (LBNL) coordinates U.S. ATLAS involvement in DOE 2000

DOE2000 & Grid Integration

- Will integrate all collaboration tools into a simple, easy to use package (Collaboration Management framework)
  - Being integrated into overall Grid R&D program
  - Will also support shared data views and analysis control
- Will investigate integration of ATLAS Analysis Framework

Stu Loken

Software Support - WBS 2.2.4

- **Facility subproject**: Support for third party tools, facility related tools, production & data distribution software, computing environment
- **Software subproject**: U.S. support for ATLAS offline software: Software Librarian function
  - Basically, software in the CVS repository
  - Support function close to the expertise base
  - U.S. installations of core and subdetector software driven by U.S. needs; help for U.S. usage issues
  - Oversight by Software Support Coordinator
    - An active physicist/developer at BNL well connected to community needs (currently Srini Rajagopalan)

Software Training - WBS 2.2.5

- Until the completion of the ATLAS Physics TDR, procedural Fortran was the primary ATLAS language
- Major transition to OO/C++ now underway
- A developer community skilled in the new tools and technologies is vital to the transition
  - Experienced software developers, including computer professionals, now working on core software projects as well as advising and contributing to analysis development.
  - Software training programs being employed both at CERN and in the U.S. aimed primarily at the physicists who will be writing the ATLAS analysis code.

Software Training in the U.S.

- US-ATLAS (Frank Merritt) has organized four professionally-taught courses in OO analysis and related subjects
  - Widespread participation: 38 US-ATLAS physicists from 8 universities, 3 national labs, and all of the main US subdetector systems.
  - Well-received by the students, most now engaged in software development for ATLAS subdetectors.
- We believe the U.S. is in a strong position to play a significant role in the development of analysis software for ATLAS.
- Will continue to grow the skills of the U.S. community

Skills and Training Survey

Name	Institution	Group	Courses needed (X means wants to take)					Email
			OOAD1	C++	AdOOD	Geant4	Java	
Hinchliffe, Ian	LBL	*Physics						I_Hinchliffe@lbl.gov
Protopopescu, S.	BNL	Core	Have	Have	Have			serban@d0.phy.bnl.gov
Toft, Craig	LBL	Core	Have	Have	X	X	X	cmtoft@lbl.gov
Malon, David	Argonne	Core, Tilecal	Have	Have	Have	Have	X	malon@anl.gov
Gilchriese, M.	LBL	ID						iglp@lbl.gov
Calafiura, Paolo	LBL	ID/ST			X	Have		PCalafiura@lbl.gov
Siegrist, Jim	LBL	ID/ST	X	X	X	X	X	jlsiegrist@lbl.gov
Vacavant, L	LBL	ID/ST	Have	Have	X	Have	X	L_Vacavant@lbl.gov
Assamagan, Ketevi	Hampton Univ	ID/TRT	X	Have		Have		Ketevi.Adikle.Assamagan@cern.ch
Baker, Keith	Hampton Univ	ID/TRT	Have			Have		baker@sobel.gov
Liu/Hong, Fred	Indiana	ID/TRT	Have	Have		Have		fred@bolitic.physics.indiana.edu
Menara, Andrea	Indiana	ID/TRT		Have		Have		Andrea.Manara@cern.ch
Vassilakopoulos, Vas	Duke	ID/TRT		Have		Have		vassilis@phy.duke.edu
Lanni, F.	BNL	LAr	Have		X	Have		flanni@bnl.gov
Ma, H.	BNL	LAr	Have		X	?		hma@bnl.gov
Rajagopalan, Srini	BNL	LAr	Have		Have	Have		srinir@sun2.bnl.gov
Stumer, I.	BNL	LAr	Have		X	Have		stumer@bnl.gov
Fanyaev, Sasha	BNL	LAr	Have		Have			fanyaev@rhic.bnl.gov
Dodd, Jeremy	Columbia	LAr	Have					dodd@nevis1.nevis.columbia.edu
Leitchouk, Mikhail	Columbia	LAr	Have	?	X	X	Have	leitchou@nevis1.nevis.columbia.edu
Parsons, John	Columbia	LAr	Have	X	X	X		parsons@nevis1.nevis.columbia.edu
Seligman, Bill	Columbia	LAr	Have	X	X	X		seligman@nevis1.nevis.columbia.edu
Seman, M.	Columbia	LAr	X	X	X	X		seman@nevis1.columbia.edu
Lach, Peter	Univ of Arizona	LAr	Have			X		lach@physics.arizona.edu
Nevski,Pavel	BNL	Muon	Have	Have				nevski@bnl.gov
Wenaus, Torre	BNL	Muon	Have	Have	Have	Have		wenaus@bnl.gov
Shank, Jim	Boston University	Muon	Have		Have	Have		shank@bu.edu
Diehl, Ed	Univ of Michigan	Muon	Have		X	X		diehl@umich.edu
Rau, Churlisu	Univ of Michigan	Muon	Have	Have				churlisu@umich.edu
Hsu, Saam	Univ of Michigan	Muon	Have			X		suen.hou@cern.ch
Levin, Dan	Univ of Michigan	Muon	Have	X	X	Have	X	dalevin@umich.edu
Kehoe, Shawn	Univ of Michigan	Muon	Have	X	Have		X	kehoe@umich.edu
Xu, Qichun	Univ of Michigan	Muon	Have					xuq@umich.edu
Zhou, Bing	Univ of Michigan	Muon	X	?	X	X		bzhou@umich.edu
Adler, S.	BNL	Muon?	Have					adler@rsaadler.phy.bnl.gov
Stratos, E.	BNL	Muon?	Have	X	Have	X		stratos@bnl.gov
Gunter, David	Argonne	Tilecal	Have	Have				gunter@mcs.anl.gov
McCompte, Tom	Argonne	Tilecal	X	?	Have	Have		tmccompte@anl.gov
May, Ed	Argonne	Tilecal	Have		X	Have	X	may@anl.gov
Price, Larry	Argonne	Tilecal	X	X		X		price@anl.gov
Wagner, Bob	Argonne	Tilecal	Have		X	Have		rgwc@fnl.gov
Anderson, Kelby	Univ of Chicago	Tilecal	Have	X	X	X		kelby@hep.uchicago.edu
Cancelo, Gabriela	Univ of Chicago	Tilecal	Have	Have	Have	Have		cancelo@hep.uchicago.edu
Gupta, Ambreesh	Univ of Chicago	Tilecal	Have	Have	Have	Have		agupta@hep.uchicago.edu
Merritt, Frank	Univ of Chicago	Tilecal	Have	Have	Have	Have		fmerritt@hep.uchicago.edu
Oreglia, Mark	Univ of Chicago	Tilecal	Have			Have		oreglia@uchicago.edu
Pilcher, Jim	Univ of Chicago	Tilecal	Have	X		Have		pilcher@hep.uchicago.edu
Blair, Bob	Argonne	Trigger				Have		rwb@anlhep.hep.anl.gov
Dohlerath, Jim	Argonne	Trigger	X	Have		Have		dg@hep.anl.gov
Abolins, Maris	MSU	Trigger	X	X	X	X		abolins@pa.msu.edu
Brock, Ray	MSU	Trigger	X					brock@msupa.pa.msu.edu
Hauser, Reiner	MSU	Trigger	Have	Have				
Pleiano, Beatriz	MSU	Trigger		Have				
Pope, Bernard	MSU	Trigger	X	X	X	X		pope@msupa.pa.msu.edu
Doberrig, Haimo	Wisconsin	Trigger						haimo.georg.zoberrig@cern.ch
Name	Institution	Group	Courses needed (X means wants to take)					Email
			OOAD1	C++	AdOOD	G4	Java	

Broad survey of U.S. ATLAS skills and interest performed by Frank Merritt

Basis of course planning

US-ATLAS Software Courses

- **"Principles of Object-Oriented Analysis and Design Using UML", taught by Object Mentor Associates (Chicago-based firm which has previously taught courses for BaBar and STAR):**
  - **Brookhaven, August 9-13. 14 students.**
  - **University of Chicago, September 21-24. 15 students.**
- **"Hands-On Geant4 Tutorial", taught by Andrea Dell-Acqua (CERN, Geant4 development team).**
  - **Fermilab, November 8-12. 18 ATLAS physicists and 6 students from other experiments (CDF, D0, CMS).**
- **"Advanced Object-Oriented Analysis and Design Patterns", taught by Object Mentor Associates:**
  - **Planned for March 2000, >13 physicists anticipated.**

Common Projects

- From early discussions within U.S. ATLAS and with (U.S.) CMS software leaders Lucas Taylor, David Stickland
- As in U.S. ATLAS/U.S. CMS computing projects overall, common project efforts must proceed in the context of the ATLAS and CMS computing programs as a whole
  - Cannot 'go it alone'
- Many common areas already identified in the LHC program have with well-developed common efforts in place
  - RD45 persistent data storage
  - Geant4 object-oriented simulation
  - LHC++
- Common U.S. ATLAS/U.S. CMS needs in distributed data management and analysis already driving common efforts
  - Addressed in the complementary programs discussed in the common projects session
    - Particle Physics Data Grid, MONARC, GriPhyN, APOGEE

Common Projects (2)

- Beyond these established areas, strategy in pursuing new ones
  - Small component packages developed by small groups and centrally integrated/managed probably most practical
  - Consistent with favored modular component architectures and widespread use of toolkits and utility libraries
  - Implies a community-wide organization for central management
    - LHC++ exists
  - Many examples in open software

Common Projects (3)

- Within U.S. ATLAS/U.S. CMS scope, some areas mentioned in discussions, some highly tentative...
  - Detector description tools, other XML applications
  - Collaborative tools
    - Definite interest in Syncomat; being pursued
    - U.S. ATLAS involved in DOE 2000 deployment in LHC in general
  - Training
  - Offline framework/architecture
    - CMS planning architectural review in a few months; interest in at least an inter-experiment discussion forum on architectural design (next slide…)

GAUDI as basis for common projects??

- Selection of LHCb's GAUDI as basis for initial ATLAS framework provides potential avenue for common projects
- Interest exists in reuse of framework/architecture ideas, designs
  - Series of architecture discussions last summer among the LHC experiments initiated by John Harvey (LHCb) regarded as very successful
    - Interest in reviving them in (U.S.) CMS
- Long term collaboration on code much more challenging
  - Experience shows this is difficult
  - Interest -- and good basis for collaboration -- in U.S. ATLAS
- Contingent upon decisions in ATLAS, CMS, LHCb
  - U.S. can bring interest in exploring collaboration, and a central ATLAS role, to the discussion

Geant4

- Geant4 will be used as simulation toolkit by ATLAS, CMS
- Successful example of a community project with highly distributed development
- U.S. ATLAS and U.S. CMS both active as users/validators of Geant4 but not as collaborators
  - Only one known current collaborator on G4 in U.S. ATLAS and U.S. CMS (Vladimir Sirotenko, N. Illinois U, ATLAS)
  - Partly arising from threshold participation required in MOU organization post-'98
  - Geant4 organization makes collaboration valuable: 'tiered' support

Geant4 in U.S. ATLAS

- Data management in support of simulation
  - Staged approach to implementing data access and storage for Geant4 simulations
    - MC events (4/00), hits (8/00), digitizations (11/00), detector geometry (4/01)
- Detector simulation with Geant4; test beam analysis to verify Geant4
  - Si tracker, TRT, LAr, Tilecal, Muon
  - U.S ATLAS Geant4 course attendees active
- Geant4 geometry optimization
  - Muon group plans tools to tune CPU/memory optimization between volume parameterizations and instantiations
- Increased activity should enable more direct Geant4 participation by U.S. ATLAS

Summary, Conclusions

- The U.S. ATLAS software program has leveraged U.S. experience and capabilities to establish leading roles in core software areas key to ATLAS physics analysis
- Our subdetector software program is a broad effort covering all areas of U.S. subsystem activity, supported by an active training program in the new software technologies of ATLAS
- Benefiting from the close coupling of our core software programs and the relevance of core work to subdetector efforts, we are linking core and subsystem development in testbed and prototype environments to closely connect core development with real-world needs and provide design feedback
- Carefully prioritized manpower requests cognizant of funding realities are being presented in the areas in which an early ramp is most vital
- We are working within the ATLAS computing organization and following ATLAS directions, but in key areas are playing a large role in setting those directions and leading the way in real-word applications